Photonic Integrated Circuits Using III-V/SOI microresonators

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I. Introduction

The silicon-on-insulator (SOI) waveguide based photonic integrated circuits(PICs) are a promising, and perhaps the only, alternate for the electronic integrated circuits as electronics based devices are power hungry and are reaching their speed limit. However, due to its indirect bandgap the silicon is not a good material for the active photonic functionalities such as memory elements (flip-flops) and shift registers etc. Therefore, in order to realize the complex PICs in a cost effective manner, which include active components and devices, it has became necessary to integrate III-V material on SOI. Here, we present the work done with microdisk resonators heterogeneously integrated onto the SOI waveguide circuits to realize the building blocks for PICs.

II. Device Fabrication And Results

Material used for making microdisks is InP-InGaAsP and is bonded on top of SOI waveguides with divinylsiloxane-bis-benzocyclobutene (DVS-BCB) [1]. After bonding process, microdisks are carved out by dry etching process and finally metal is deposited on top and the bottom of the microdisks for electrical contacts. Details of the fabricated microdisk are shown in fig. 1.

In the unidirectional regime of microdisk lasers, the output of one of the modes (clockwise-CW or counterclockwise-CCW) is high while that of another is suppressed. The output power of the dominant mode can be suppressed while that of the suppressed mode can be enhanced by injecting an external optical pulse in the direction of the suppressed mode. This way, depending on the direction of injection of the external optical pulse, the random switching between CW and CCW modes is demonstrated [2]. This phenomenon is equivalent to electronic set-reset flip-flop.

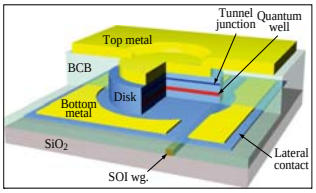

Figure 1. Schematic of microdisk resonator

Gating operation at the speed of 10GHz is shown in pump-probe configuration with the probe beam tuned at one of the transmission resonances and the pump at another [3].

III. Conclusion

We have demonstrated the use of III-V/SOI microdisk resonators for realizing the all-optical functionalities. Their low foot-print and lower power consumption makes them an ideal candidate for the cost effective production of photonic chips to be used for high speed computing and communication.

References

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[2] L.Liu, R.Kumar et.al, Nature Phot., vol. 4 (2010) 182.

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